A Slice of Research Life:
Information Support for Research in the United States

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OCLC®

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Executive Summary

Recent downturns in the economy have hampered state support for research institutions and reduced income from shrunken endowment accounts, encouraging universities in the United States to aim for a larger influx of research dollars as a way to counter-balance restrictions of other revenue streams. The average age for first-time Principal Investigators has increased to 42.6 years. The success rate for grant applicants has decreased from 31.6% in 2000 to 20.6% in 2009. Together, these factors produce greater intensity in competition for research awards and increased pressures felt by today's investigators.

Meanwhile, technological innovations roll out at a rapid pace, offering new options for how scholarly work proceeds throughout the course of the research life cycle. Advances in hardware and software afford new opportunities for providers and consumers of information and information-related services. Researchers have quickly adapted to products that expedite their work, while rejecting those tools and services that do not offer ease of use and sizable payoff. In interviews with 38 individuals at four prominent U.S. research universities, respondents reported how they use information in the course of their research, what tools and services are most critical and beneficial to them, where they continue to experience unmet needs, and how they prioritize use of their limited time.

Relationships between researchers and traditional library and university support for research have shifted radically. Given major time constraints within which they all work, investigators use and prefer easy solutions that are adequate, not optimal. The majority of researchers interviewed for this study use online tools and commercial services related to their discipline rather than tools provided by their university. Structured interviews revealed that researchers today derive great benefit from using network-level search engines such as Google and from convenient access to electronic journals. Despite tremendous advantages offered by digital access and networking, however, the stellar productivity of U.S. researchers continues to be built on a foundation of direct human connection, researcher to researcher.

Researchers report that they struggle unsuccessfully with storage and management of a burgeoning volume of documents and data sets that they need and that result from their work. While some universities have devised new services to better manage data and other information derived from research, many researchers flounder in a disorganized and rising accummulation of useful findings that may be lost or unavailable when conducting future research.

Introduction and Study Methodology

In the spring of 2009, OCLC Research and the Research Information Network (RIN) initiated parallel investigations into current use of tools and services that support of all stages of the research life cycle in institutions of higher education in the U.S. and the United Kingdom. The goal of these joint projects was to discover researchers' needs and desires in a variety of disciplines as they perform the complex tasks of creating new knowledge. By focusing on the tools and services used by researchers, the two studies were to document how these support elements are being used at the present time, how effective they are in meeting researcher needs, and whether there are existing unmet needs that are common to all disciplines or that vary by field.

OCLC Research engaged Kroll and Forsman to:

- Conduct a literature search of relevant studies of a similar nature

- Select four prominent U.S. research institutions to be visited for interviews with active researchers

- Design a set of interview questions

- Conduct interviews at the four institutions

- Prepare a report on the findings of the study

This report summarizes the information gained through interviews held with researchers, research assistants, graduate students, grant and other research administration specialists, and university administrators. Four elite research universities—Cornell, the Ohio State University, Vanderbilt and the University of Washington—were selected for their exemplary reputations for innovative research support services, and for their geographical and organizational diversity. Selection criteria and interview methodology were aligned by Kroll and Forsman in collaboration with the RIN consultants.

In the U.S., introductions to selected researchers and their teams were arranged by provosts and deans responsible for research at each university. Entrée at the university level—rather than through librarians and the libraries—avoided influencing respondents to mention libraries and their services. Interviewees represented a wide mix of disciplines in the humanities, social sciences, hard and life sciences, and inter-disciplinary programs.

Structured questions were informed by documented "primitives" of the traverse of scholarly research workflows (University of Minnesota Libraries 2006, Palmer et al. 2009). Questions were designed to pay particular attention to the impact of support services, how these might influence the way research is conducted, and any perceived gaps or needs. Throughout the interviews, researchers shared details about their specific work and offered intriguing observations about the changing landscape around them. This report includes a sampling of direct quotations that exemplify either common opinions or unique perspectives.

It should be emphasized that the findings reflect the perspective of many pre-eminent researchers and their circles at leading U.S. research universities. Experiences of all researchers may not always follow the same pattern, and it can be anticipated that interviews in other settings might point to different conclusions.

The report is organized according to specific topics or tasks that frequently require or benefit from the use of information-related tools and support services during the research life cycle. The findings are qualitative and may spur more extensive study.

Learning About Grant Funding Opportunities

"Sources of funds are obvious, limited, and easy to monitor." —research support staff

When asked how they learn about grant and other funding opportunities relevant to their work, researchers report that this is a straight-forward task. Their universities have some form of central facility for managing grants and contracts, and staff in these units routinely seek to maintain broad awareness of forthcoming research funding. Likewise, most academic departments have staff who look for information regarding new opportunities in a specific discipline. Both the central office and departmental staff circulate announcements they believe will be of interest to specific individuals. Some of the researchers interviewed for this project are leaders in their field and are frequently invited by private foundations to submit grant applications.

Researchers also receive announcements directly from various funding agencies, and they report satisfaction with the periodic email messages they receive from major federal agencies such as the National Science Foundation or National Institutes of Health. Most of the researchers interviewed have a clearly defined scope to their efforts and need to pay attention to only the information releases of a small number of funding agencies or foundations. Between what they receive directly from such sources and what is forwarded to them from within their university, most researchers feel confident that they are able

to track the most important funding opportunities. This is not as true for those engaged in multi-disciplinary or international research, where it may be necessary to monitor a broader array of funding sources. In these settings, some researchers worry about missing out on information related to new funding and are less satisfied with the process of staying informed.

Managing Intellectual Property and Exploiting Commercial Value

"We are supposed to produce knowledge, so why shouldn't we make it available?" —physics

Researchers describe a wide variation in how they manage intellectual property, how likely it is that commercial value could result from their work, and how their given discipline treats both of these elements. To a large extent, those in the arts, humanities and social sciences state that there is little or no commercial potential of their research. In fact, the culture of some fields is such that there is considerable peer pressure to place results into the public domain and to share locally developed products like analytic software as freeware that can be readily used by colleagues across the country. As expected, researchers in the sciences are more likely to make discoveries that can be commercialized, and there remains an incentive for paying attention to copyright and other mechanisms for preserving intellectual property rights. The issue of intellectual property did evoke strong reactions from several of the researchers who have had negative interactions with their university's attorneys. Most have tried to avoid copyright practices that would cause problems through the use of passwords and other security measures.

All of the universities in this study—selected for their reputations for excellent research support services—have offices that deal with legal and technology transfer issues. Researchers are aware of these and tap them as needed. Only one or two faculty members say they look to the library for information regarding copyright, licensing, and referrals to other experts on campus. For the most part they focus more on the conduct of their research and pay limited attention to these two concerns.

Finding Potential Collaborators and Making Themselves Visible to Others

"Even junior faculty quickly find partners and after two or three years don't need more collaborators."
—informatics and global health

More and more research is of a complex nature that benefits from the involvement of people with complementary knowledge and skill sets. Some faculty opine that research in general is increasingly multi-disciplinary, as opposed to past efforts that were handled within one's home department or unit on campus. In some fields collaboration remains limited to colleagues within a department, school or campus; in other instances collaboration relies on researchers from different disciplines or institutions. Frequently today's scientific research activity has moved beyond the lab of an isolated individual and usually demands the participation of a team. Faculty in the arts who were once individual practitioners find themselves working with new international colleagues working in similar areas. Researchers appreciate that they must involve others with specialized knowledge and skills, but they also express some discomfort at not fully understanding the complementary domain expertise they must now rely upon.

Interviewees have no difficulty finding collaborators, perhaps in part because generally they are—or work with—faculty who are well established and have many connections in their field. Almost all researchers have created a strong network of friends and colleagues and they draw together the same team repeatedly for new projects, or tap into their network to form new teams that best fit interests and funding opportunities. All the scholars studied have very busy research agendas and they do not always have uncommitted time that could be offered to new partners in another unit or institution. Hence, interviewees state that they spend little effort looking for potential collaborators and frequently do not wish to be approached by anyone outside their current circle.

When describing how they look for collaborators, some faculty members mention the convenience of Google, Web of Science, Google Scholar and online research publications as a way to identify who is doing related work and to learn something about an individual's background. However, when it comes to making a decision about working closely with another person, fundamental human behavior trumps electronic information. Everyone emphasizes the paramount importance of interpersonal contact as the vital basis for agreeing to enter into joint work. Personal introductions, conversations at meetings or hearing someone present a paper were cited as key in choosing collaborators. Researchers rely on that one-on-one opportunity to assess the other person and the degree of compatibility, something that

cannot occur when looking at Internet sources or formal publications. Junior faculty, graduate students and research assistants follow the same pattern of face-to-face contact in building their collegial community.

Management and Storage of Documents and Data Sets

"I feel every university has to build a culture that values data integrity." —psychology

"You can get a bucket of bits but can't make sense of them." —physics

While scholars feel comfortable with several aspects of their use of information tools and services, this is the category where they articulate the greatest discontent and concern. Because most interviewees are accomplished investigators, over time they have amassed an extensive body of work in the form of documents or data sets. Researchers worry about valuable earlier work that they still store, but that in reality is unavailable for use because it is recorded on outdated media (e.g., floppy disks), formatted for obsolete software, or relies on antique programming languages. Some indicate that they would repeat a prior experiment rather than attempt to retrieve older data. While work that researchers produce today does not yet face these challenges, over time they are potential victims of the same circumstances, since there are no organized schemes for managing data as information technology evolves.

Few universities have developed successful service centers that take on the storage, maintenance and retrieval of research documents and data. In some cases such services are licensed by other universities. Most researchers use a hodge-podge of approaches including:

- storing lab books, printouts, and other hard copy items in files or on bookcases in their office or lab

- retaining working files or early analyses on whatever computer was initially used to create them, including the computers of students or research assistants who are likely to depart

- storing files and data on a variety of devices within in the lab or home department of the researcher

- storing files and data at sophisticated computer centers at other universities with advanced features for data sharing, personal de-identification, or other analytical and re-use options not available elsewhere

Researchers are most likely to store items within their lab or department when they are dissatisfied with central support services on the campus. This assessment often depends upon the perceived responsiveness or inflexibility of central information technology staff. Conversely, researchers spoke most highly of local campus service centers or remote providers when those information services are run and policies are set by fellow faculty, or when the service center philosophy stresses fulfilling faculty needs.

In large universities, the research enterprise is necessarily handled in a decentralized fashion. Researchers often must find their own solutions for document and data storage and maintenance. They may be uninformed about what is being done within the institution. For example, researchers using genetic data may not know that the university licenses specialized software to store and maintain such data for other units on campus. In some instances, the library or a central information technology unit is hosting an institutional repository (IR) where faculty may place the products of their work, but the researchers interviewed find the IR to be only partially successful. Researchers generally report that they have no time to take on the burden of uploading their work to an IR, devising metadata, and creating useful organization. Based on the comments during this study, it appears that universities are doing a uniformly poor job storing, maintaining, and providing access to the discoveries they are encouraging their faculty to pursue through the research process. Individual faculty members are unable to solve this problem themselves; meanwhile, many continue to store documents and data in a haphazard manner.

Analysis of Large Text and Data Files

"Programmers have the answers but don't know the questions to ask. I have the questions but don't know the answers. There are only a handful of people who can do both." —genomics

Many researchers express frustration with how technical data analysis has become, now requiring outsourcing to statisticians. Where researchers do perform data analysis, most mention using a variety of software to conduct analysis of numeric files or combinations of numeric and textual data stored in structured records, such as astronomy data or organized patient records. Researchers rely on a broad range of commercial products to conduct analyses tailored to the type of data, with various proprietary statistical software being mentioned most often. There are a few reports of researchers writing the program they need and analyzing large text files themselves. For specialized fields where there is not a large market for commercial products, freeware is commonly used and modified to meet local

needs. Freeware is most evident in fields where findings are quickly placed into the public domain or the prevailing culture is to share results without undue restrictions.

Improving Information Retrieval and Management Skills

"I used to use the library to obtain all my research information, but now I use Google Scholar."
—sociology

All researchers relegate this low in their priorities. Most scholars are aware that rapid changes in information technology threaten to eclipse the effectiveness of their information management and retrieval skills over time. Some express concern over this issue and describe different strategies for adding to their skills or at least keeping them current. Because researchers find Google and Google Scholar to be amazingly effective in finding isolated bits of information or getting to publications or findings of interest to them, they feel limited pressure to augment their current skills given all the other demands on their time.

A handful may be vaguely aware that the library or other central service units offer classes aimed at improving skills, and one or two may even champion in-house seminars to bolster skills within their lab or department. Still, they report their most common approach is to get by with existing skills until it is essential that they master new competencies to complete a new research project, at which point they will carve out the required time.

Managing Literature Citations

"I tried using RefWorks and EndNote but they're too much work. Using a package eliminates collaboration with those who don't use it."
—population research

Another category where researchers feel frustration and discontent is in the process of entering, storing and manipulating literature citations. EndNote, Reference Manager or RefWorks come up as being the most commonly-used products for this task, but many researchers find them cumbersome and of limited success in serving their needs. Many indicate that the degree of effort to use the software is too great, given the learning curve.

They also express little interest in using the "official software product" provided by the university. Rather, they choose software for their own convenience and its perceived usability.

While a few researchers store citations in software that they mastered much earlier in their career, a large percentage rely on Microsoft Word to handle citations. In particular, faculty who collaborate with researchers in developing countries make a conscious decision to use Microsoft Word, due to its universal availability. Researchers feel it is easier to add citations to a Word file, then copy-and-paste into publications. Commercial products require researchers to fumble through steps and the citations still need considerable reformatting to satisfy publication demands. A few participants have staff who take care of this nuisance for them, but most continue to be unhappy with what is available to them for this basic task.

Choosing Where to Publish or Alternative Forms of Dissemination

"You are told which traditional journals you must publish in." —social sciences

Once again, researchers who are well established spend little time and effort on this task. In most cases, the first author of a paper makes the decision on her own. Based on past experience and intimate knowledge of the major publications in their field, researchers know which journals they will target for publishing the results of their latest projects. In fields with traditional emphasis on publication for tenure and promotion, authors prefer journals that have high impact rankings and the prestige of being in the top tier in a subject domain. For those working in multi-disciplinary or international projects, the range is somewhat less defined and authors may give additional thought to selection of the best journal for showcasing their findings. Multi-disciplinary work also causes authors to look towards high-level publications such as *Science, Nature* or *Daedalus*.

Faculty say that they are aware of the benefit of publishing in open access publications, avoiding titles that impose fees for article length, and titles that do not embargo electronic access. In fact, several faculty remark that they have reached a stage in their career where publication is no longer so critical to promotion and tenure, thus they actively elect to publish in online journals that offer easier access to the rest of the research community. Some faculty members have been involved in the launch of new electronic journals. These may erode the restrictive control of traditional publishers and are likely to have a growing impact over time. In several of the interviews, the issue of open access publishing elicited strong support with faculty who want to share their publications freely. However, faculty express a strong preference for their graduate students to publish in traditional high-impact journals.

In some fields, such as digital media, traditional publication is not important at all. In other fields, such as computer science, there is a strong preference for presentation of findings at conferences, and formal publication is seen as a waste of time and energy. All faculty mentioned the importance of online journals and how they are changing information access and retrieval.

Support for Promotion and Tenure

This topic is of little concern to prominent researchers, all of whom are well regarded and valued by their institution. Participants in this study have records of research productivity and professional networks, and they are not concerned with information tools or services that support promotion or tenure.

Professional Standing

"It's hard for an individual to manipulate or hide information because of Google. It's not really possible to 'manage' one's reputation."
—bioinformatics

The issue of professional standing parallels the faculty comments regarding collaboration. While some objective measures of standing and professional success are important acknowledgements of one's research portfolio, in many ways these are less significant when assessment and feedback are less personal. Researchers feel most richly rewarded when they receive positive recognition from people they know and respect. Many care deeply about the success of their graduate students, post-docs, fellows and classes they teach. They seek opportunities to increase the reputation of their graduate students. Consequently, impersonal electronic information is of much less interest.

Faculty routinely admit that they spend little time entering or updating their professional information into websites of any kind, and they are skeptical of the reliability of what they might find when searching individuals in institutional websites or expert profiling sites, such as Community of Science. Conversely, they are deeply concerned about issues related to attribution of their research and evidence of authenticity for all their data. In some cases, researchers review the publications of others they do not personally know and draw conclusions from their formal scholarly record, but they are just as likely and sometimes more satisfied by tapping into their professional network of friends and colleagues when looking into a person's stature.

Managing Pre-prints, Publications, and Post-prints

"I load the pre-print on my website because it is a better representation of my original research than the edited version in the final publication."
—economics

*"I used to store the PDFs. Now I just store the links."*
—physics

The explosion of electronic journals has transformed how faculty disseminate and store their work. In a few disciplines, various versions of research findings have discrete value, and in these instances pre-prints may be shared and preserved or post-prints are stored in order to document subsequent developments that occur after formal publication. Most researchers find they can do away with paper reprints and do not need to be concerned with sharing pre-publication papers when their colleagues will have ready access to an electronic article that can be revisited online whenever needed. Some faculty have systematically disposed of paper reprints, either creating an electronic file with a link to the digital article or simply planning to search for such a link at the point of need. Despite expressing some worry about early products of their research that cannot be used because they are in obsolete formats, no faculty voiced concern that electronic articles might become similarly dated or unavailable at a future date. There is an implicit assumption that today's electronic journal content will be refreshed and digitally manipulated as required to carry it forward indefinitely over time.

Conclusions

data
management

personal
relationships

eJournals

library
future?

ease and
efficiency

1. Researchers Value Ease of Use and Increased Efficiency.
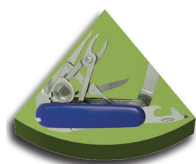
Researchers live by satisficing. Because of tremendous pressures on their time, researchers adopt information tools and services that are easy to use and that simplify their work, even when those tools and services are not optimal, comprehensive, or on the "approved" list preferred by their university. Researchers take advantage of Google for many kinds of information searches, recognizing that this search engine may not produce precise or complete retrieval but accepting its results as being 'good enough' in many cases. When information tools are complex, time consuming, or otherwise burdensome (such as literature citation packages or institutional repositories), researchers choose not to use them and make do in other ways. Even if support services are not perfect, they will be embraced as long as the tools allow researchers to work faster or simplify their life in some significant way.

2. Electronic Journals Continue to Reshape the Information Landscape and the Research Process.
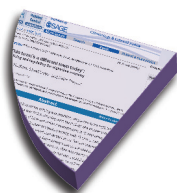
Although this study deliberately focused on services—not library content—scholars nevertheless consider electronic journals a "service" that supports their research. They have quickly come to rely on access to electronic journal content but spend little or no thought on how that content is made available to them, what long-term storage issues might exist, or other aspects of the intricate digital environment. While one or two researchers voice regret that they have lost touch with the library, all of them have been impelled to change their habits in favor of electronic access. Some respondents appreciate that the library had the vision to invest heavily in electronic journals, yet in their hectic work life the role of the library in maintaining digital access is invisible. Electronic publishing has begun to loosen the control of traditional and restrictive publishers, and it can be expected that researchers will continue to push forward in ways that make new models more responsive to their own needs. Specialty fields may have greater impact in changing the future of publication because they are less bound by traditional publishing patterns.

3. No One Has Control Over Nor Plans for Managing the Storage, Maintenance, and Retrieval of Documents and Data Sets Over Time.

Research findings and products are scattered across institutions, older documents and data are becoming inaccessible, and it is uncertain how today's digital content will be carried forward as information technology evolves. Most universities have not addressed this concern and researchers are unable to do so individually. Missed opportunities and duplicative research are likely due to the difficulty to identify what was done in the past. Only one of the universities participating in this study offers services that researchers really use to keep their intellectual assets at the university. The vast wealth of U.S. research findings are not brought together in an efficient manner except in strong discipline-based and centralized repositories, such as PubMed Central.

4. Scholarship Rests on the Foundation of Personal Relationships.

It does not appear that professional networking Websites will attain a high level of regard or participation. Despite all of the technological advances, researchers depend upon personal introductions and face-to-face interaction. Faculty and staff at all levels use direct contact as the initial step in any decision to work together. Technology cannot replace that human factor, and tools or services without that element are not well accepted. Junior faculty rightly

recognize the imperative to attend professional conferences as they establish themselves and develop their personal network for the remainder of their career.

5. Libraries Must Articulate and Create Their Own Future.

Researchers have no perception of the huge internal transformation most libraries have undergone in the conversion to digital access. Researchers do not realize what expertise librarians have to offer their users, are uninformed about services offered, and have little idea what the library might do in the future. Not one person reported that they visited a library. A wide variety of researchers voice their inability to create consistent and shareable metadata and their disorganized storage strategies. Yet it does not appear that they see libraries as having much to offer in any of these areas. Researchers require practical evidence of direct value of research tools and services. Academic libraries can support research by developing and aggregating discipline-based tools, providing customized services, and emphasizing user-centered services.

Appendix A: Characteristics of Interviewees

Positions:

Art Curator

Associate Professor

Chair, Research Computing Committee

Dean

Full Professor

Graduate Student

Grant Manager

IT Director

Research Assistant

Research Support Services staff (including both grant and lab management)

Vice President of Research

Departments and Disciplines:

African Studies and African Art

Astronomy

Bioinformatics

Computer Science

Digital Arts

Digital Media

Economics

English

Geography

Global Health

History

Health Research

Latin American Studies

Life Sciences

Mathematical Ecology

Mechanical Engineering

Medicine

Music History

Physics

Population Research

Psychiatry

Psychology

Sociology

Veterinary Medicine

Appendix B: Examples of Research Support Tools and Services Used and Desired by Researchers

Participants most often named discipline-specific research services. Many of the myriad tools for specific disciplines mentioned during the interviews have been created and supported by universities, such as arXiv.org, QTL, REDCap, and Coeus. Cornell's arXiv.org, named by at least one researcher from every university visited, provides open access to e-prints in the sciences. QTL is a suite of programs from North Carolina State University that are used in genetics and bioinformatics. REDCap, used to build and manage web-based databases, was developed by Vanderbilt, but some researchers at OSU and UW also say they use REDCap in the course of their own research. MIT developed Coeus, a cradle-to-grave grant project routing system that a scholar at Vanderbilt uses.

Researchers and their staff speak of a large number of tools and services focused on their particular specialties that scholars have built themselves on behalf of colleagues world-wide. For example, SNPedia is a wiki for human genetics. NeuroTree is an example of DIY website databases that track "academic genealogy" in a particular subject, in this case neurosciences. Volunteers maintain similar home-grown web-based hierarchies of intellectual heritage for economics and geology. DevEconTree is an online database of economists developed by Cornell grad students.

Other discipline-specific research tools and services used by these researchers are commercial, government-funded, or come from the community itself. SPSS and SAS, often named in interviews, are well-known examples of commercial tools for statistics. Web of Science and Community of Science—mentioned less often and not always favorably—are commercial expertise services. A few participants rely on government-funded information services, for example two supported by NASA: NstED—a database of stars and planets hosted at CalTech—and Harvard's ADS, which aggregates access to over 8 million records of astrophysics articles.

The scholars and their staff name a variety of general research support services that they use in the course of their research. Most are tools that people cobble together themselves, with whatever is at hand, easy-to-use, or inexpensive. Many researchers manage their data and do statistical analysis in spreadsheets. Repeatedly, participants prefer word-processing cut-and-paste for managing citations. Some mention RefWorks and EndNote (not often favorably), commercial citation-management programs usually licensed by universities or libraries. One scholar uses SharePoint, a very expensive commercial product paid for by the university, for collaboration.

On the other hand, a large proportion of the interviewees find free programs on the web and some write code themselves when they need to. Many interviewees say they

are uncomfortable managing and storing their data and documents themselves—on their laptops and flash drives—but that's what they do. One digital arts research team expressed reservations about "keeping" their projects and performances on YouTube.

Campus-wide services, such as OSU:pro and VIVO, both expertise profiling systems, were named by just a couple respondents, and only as a service they prefer not to use. On the other hand, Vanderbilt's Advanced Computing Center for Research & Education (ACCRE) was often reported to be both used and highly valued.

Almost all of the interviewees name Google and Google Scholar as services they use to discover information. Well-known off-the-shelf software—such as Microsoft Word and Excel—is used ubiquitously. This is further evidence of preferences for services that are convenient, easy, and embedded in their workflow.

Several researchers describe particular research support services they lack. Data management and storage topped the list of gaps in research tools and services. As an example, a researcher in digital arts says he needs "something to handle all the media and metadata." A computer scientist commented that, due to inconsistencies, "Data access by outsiders is difficult; [there's] no attention or maintenance once data is stored." A psychologist voiced a similar concern: "Data access and formatting are not standardized, even within one lab." A researcher in genomics needs data management broader than any one institution: "[There] needs to be more concerted efforts internationally to handle the current volume of data." One economist summed it up this way: "[I am] very concerned with public data management and ways for the University to acknowledge data collection in the promotion and tenure process. I am very concerned about the "intellectual lineage" of data and citation connections."

Many researchers want personal and department websites kept current, and lament the current disarray. An astronomer spoke for several researchers when he commented that his University does not provide support in creating website and managing content, but he'd like that. A member of the arts faculty reports that he has access to an in-house content management system but it's inflexible. A historian muses that she can't find isolated scholars working on specific subjects and she would appreciate an updated database of current research being done in areas related to hers. Interviewees in a broad range of disciplines consider keeping information on the web current to be a chore, and regret that their websites are woefully out of date.

Researchers imagine creative solutions for gaps in research support services. One of the economists described a tool like Pandora for journal articles: "Journals are like radio stations; you pick them according to your taste." An IT Director is "interested in development of the ability to map dollar expenditure with publication by project and researcher to see who's

most productive." One astronomer sees a need for "people double-trained as scientists and IT workers to manage data smarter." The African Studies art curator wants "a digital media center so [materials] are organized and searchable." In the life sciences, one participant "would be interested in tools that can scan lab notebooks and assign metadata for retrieval." A mechanical engineer says she would like a service "where someone put up her research data and allowed others to add information like a wiki." An economist describes his need in detail: "I make working papers which are under review publicly available. When they're accepted I take down the links and then release the published links. This process is very tedious and [I] would love a tool that migrates the paper according to its status."

Very few people articulated specific gaps that they expect a library to fill. A scholar of mathematical ecology expressed "some interest in seeing an institutional repository to bypass paying for licensing access to online journals." A geologist involved in an NSF DataNet proposal said he sees a national role in data management and he feels that librarians have metadata expertise that could be leveraged.

Research Support Tools and Services

ADS
http://adswww.harvard.edu/

Advanced Computing Center for Research & Education (ACCRE)
http://www.accre.vanderbilt.edu/

arXiv.org
http://arxiv.org/

Coeus
http://osp.mit.edu/coeus/

Community of Science
http://www.cos.com/

DevEconTree
http://devecontree.com/

NeuroTree
http://neurotree.org/neurotree/

NstED
http://nsted.ipac.caltech.edu/

OSU:pro
https://pro.osu.edu/

QTL
http://statgen.ncsu.edu/qtlcart

REDCap
https://redcap.vanderbilt.edu/

SAS
http://www.sas.com/

SNPedia
http://www.snpedia.com/

SPSS
http://www.spss.com/

VIVO
http://vivo.cornell.edu/

Web of Science
http://thomsonreuters.com/products_
services/science/science_products/a-z/
web_of_science

Appendix C: Interview Questions

The following structured questions were used to facilitate discussion during each interview:

1. Do you collaborate with other researchers? How do you locate potential collaborators? How do you make your expertise known to others?

2. Do you collaboratively manage documents and data generated in a research project? How do you do this?

3. Do you use any tools or services to analyze large text or data aggregations? What additional support would be desirable?

4. Do you use any tools or services to manage literature citations? What additional support would be desirable?

5. Do you use any tools or services to curate and preserve data sets generated through research? What additional support would be desirable?

6. Do you disseminate preprints of your papers? How do you do this? Do you store them somewhere? Where do you store them? What additional support would be desirable?

7. Do you store copies of your publications? Or references to them? If so, where? What additional support would be desirable?

8. Do you disseminate postprints of your papers? How do you do this? Do you store them somewhere? Where do you store them? What additional support would be desirable?

9. How do you identify the most effective manner and vehicle in which to publish? What additional support would be desirable?

10. Do you take advantage of any services to support researcher reputation management, such as citation analysis or expertise profiling?

11. Does anyone provide you with advice and guidance in protecting intellectual property rights or in making your research outcomes openly accessible to others?

12. Do you think you need to improve your information seeking and information management skills? Do you do so from time to time? If so, how?

13. How do you learn about grant or other funding opportunities?

14. Are you concerned with research topics of potential commercial value to the university? How do you identify them? Describe the process to commercialize.

Appendix D: Related Readings

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